The documentation and process conversion measures necessary to comply with this revision shall be completed by 9 January 2007.

INCH-POUND

MIL-PRF-19500/385F
9 October 2006
SUPERSEDING
MIL-PRF-19500/385E
29 August 2005

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, FIELD EFFECT TRANSISTORS, N-CHANNEL, SILICON,
TYPES 2N4856 THROUGH 2N4861,
2N4856UB THROUGH 2N4861UB, JAN, JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-19500.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for N-channel, depletion mode, silicon J-FET transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-18) and figure 2 (UB surface mount).

1.3 Maximum ratings. T_A = +25°C, unless otherwise specified. (1)

P_T (2) T_A = +25°C	P_T (3) T_C = +25°C	V_{DS}, V_{DG}		V_{GS}		I_G	$R_{\theta JA}$	$R_{\theta JC}$	T_J and T_{STG}
		2N4856 2N4857 2N4858	2N4859 2N4860 2N4861	2N4856 2N4857 2N4858	2N4859 2N4860 2N4861				
W	W	V dc	V dc	V dc	V dc	mA dc	°C/W	°C/mW	°C
0.36	1.8	40	30	-40	-30	50	486	0.097	-65 to +200
0.40 All UB (4)							325		

(1) These characteristics applicable to all package styles, unless otherwise noted.
(2) Derate linearly 2.06 mW/°C for T_A > +25°C.
(3) Derate linearly 10.3 mW/°C for T_C > +25°C.
(4) Derate linearly 3.08 mW/°C above T_C = +70°C.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil/.

AMSC N/A

FSC 5961

1.4 Primary electrical characteristics. T_A = +25°C, unless otherwise specified. (1)

	I_{DSS} (2) V_{DS} = 15 V dc V_{GS} = 0			V_{DS}(on) V_{GS} = 0 I_D = 20 mA dc	V_{GS} = 0 I_D = 10 mA dc	V_{GS} = 0 I_D = 5 mA dc	V_{GS}(off) V_{DS} = 15 dc I_D = 0.5 nA dc		
	2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	2N4856 2N4859	2N4857 2N4860	2N4858 2N4861	2N4856 2N4859	2N4857 2N4860	2N4858 2N4861
	mA dc	mA dc	mA dc	V dc	V dc	V dc	V dc	V dc	V dc
Min	50	20	8				-4	-2	-0.8
Max	175	100	80	0.75	0.50	0.50	-10	-6	-4

	r_{ds}(on) V_{GS} = 0; I_D = 1.0 mA dc I_d = 100 µA ac(rms), f = 1 kHz		
	2N4856 2N4859	2N4857 2N4860	2N4858 2N4861
	Ω	Ω	Ω
Min			
Max	25	40	60

(1) These characteristics applicable to all package styles.
(2) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

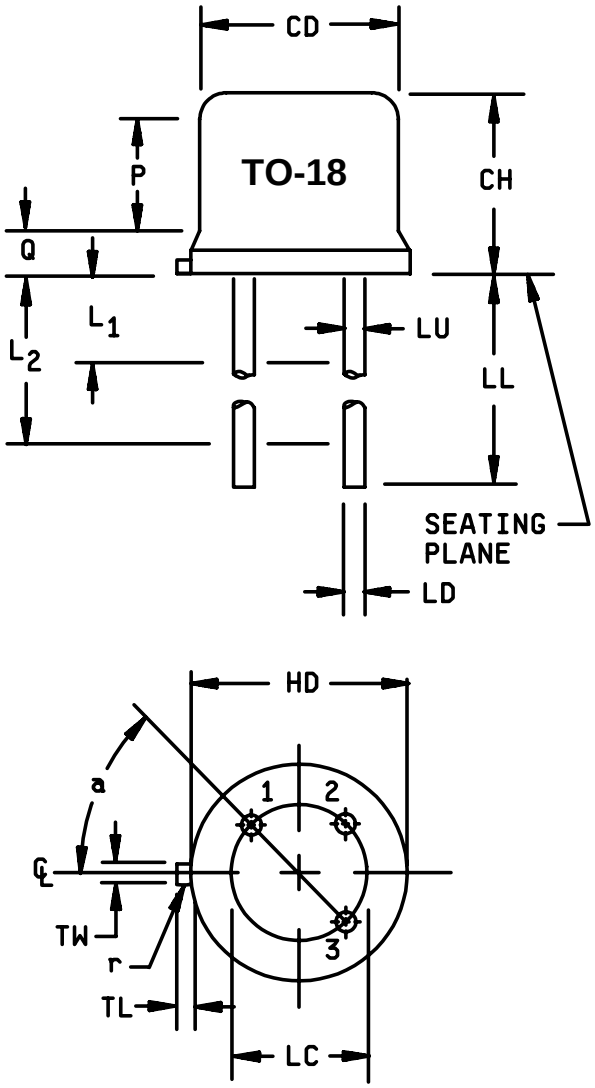
DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

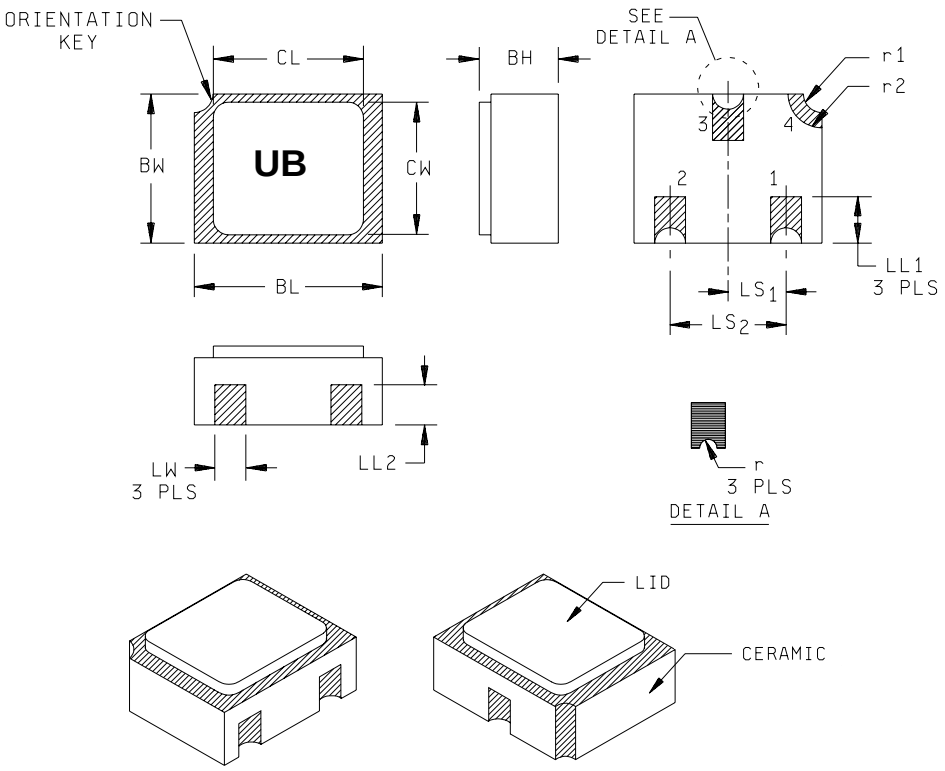
2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	5
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	4, 5
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,8
LL	.500	.750	12.70	19.05	7,8
LU	.016	.019	0.41	0.48	7,8
L1		.050		1.27	7,8
L2	.250		6.35		7,8
Q		.030		0.76	5
TL	.028	.048	0.71	1.22	3,4
TW	.036	.046	0.91	1.17	
r		.010		0.25	3, 10
α	45° TP		45° TP		6
P	.100		2.54		



NOTES:
1. Dimension are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TL shall be held for a minimum length of .011 (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by the gauge and gauging procedure shown in figure 2.
7. Dimension LU applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
12. Lead 1 = source, lead 2 = drain, lead 3 = gate.

FIGURE 1. Physical dimensions TO-18.



Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
BH	.046	.056	1.17	1.42	
BL	.115	.128	2.92	3.25	
BW	.085	.108	2.16	2.74	
CL		.128		3.25	
CW		.108		2.74	
LL1	.022	.038	0.56	0.96	
LL2	.017	.035	0.43	0.89	
LS1	.036	.040	0.91	1.02	
LS2	.071	.079	1.81	2.01	
LW	.016	.024	0.41	0.61	
r		.008		.203	
r1		.012		.305	
r2		.022		.559	

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metallized areas.
4. Lid material: Kovar.
5. Pad 1 = Drain, Pad 2 = Source, Pad 3 = Gate, Pad 4 = Shielding connected to the lid.
6. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 2. Physical dimensions, surface mount (UB).

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figures 1 and 2.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.5.1 Handling. Metal oxide semiconductor (MOS) devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended (see 3.5).

a. Devices should be handled on benches with conductive handling devices.

b. Ground test equipment, tools, and personnel handling devices.

c. Do not handle devices by the leads.

d. Store devices in conductive foam or carriers.

e. Avoid use of plastic, rubber or silk in MOS areas.

f. Maintain relative humidity above 50 percent if practical.

g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.

h. Gate must be terminated to source, $R \leq$ or 100 kΩ, whenever bias voltage is applied drain to source.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I.

3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.8 Marking. Marking shall be in accordance with MIL-PRF-19500 except for the UB suffix package. Marking on the UB package shall consist of an abbreviated part number, the date code, and the manufacturer's symbol or logo. The prefixes JAN, JANTX, JANTXV, and JANS can be abbreviated as J, JX, JV, and JS respectively.

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4 VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table E-IV of MIL-PRF-19500	Measurement	
	JANS level	JANTX and JANTXV levels
9	Not applicable	Not applicable
10	Not applicable	Not applicable
11	$I_{D(off)1}$, $r_{ds(on)}$, I_{GSS1}, and I_{DSS}	$I_{D(off)1}$, $r_{ds(on)}$, I_{GSS1}, and I_{DSS}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{DSS} = ± 15 percent; $\Delta r_{ds(on)}$ = ± 20 percent; $\Delta I_{D(off)1}$ = 0.1 nA or ± 100 percent of initial value. ΔI_{GSS1} = ± 0.1 nA or ± 100 percent of initial value, whichever is greater.	Subgroup 2 of table I herein; ΔI_{DSS} = ± 15 percent; $\Delta r_{ds(on)}$ = ± 20 percent; $\Delta I_{D(off)1}$ = 0.1 nA or ± 100 percent of initial value. ΔI_{GSS1} = ± 0.1 nA or ± 100 percent of initial value, whichever is greater.

4.3.1 Power burn-in. Power burn-in conditions are in accordance with method 1039 of MIL-STD-750, test condition A and as follows: $T_A \geq +150°C$; V_{GS} = 80 percent of rated , V_{DS} = 0. NOTE: No heatsink or forced air cooling on the devices shall be permitted.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in tables VIA (JANS) and VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

* 4.4.2.1 Group B inspection, table E-VIA (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
B4	1037	P_T = 360 mW at T_A = +30°C, ± 5°C; 2,000 cycles.
B5	1027	96 hours; V_{DS} = 15 V dc; I_D = 24 mA at T_A = +100°C; or adjust as required by the chosen T_A to give an average lot T_J = +275°C.

* 4.4.2.2 Group B inspection, table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1027	V_{GS} = -32 V dc for 2N4856, 2N4857, 2N4858, at T_A = +175°C ±5°C; V_{DS} = 0 V. V_{GS} = -24 V dc for 2N4859, 2N4860, 2N4861, at T_A = +175°C ±5°C; V_{DS} = 0 V.

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

Subgroup	Method	Condition
C2	2036	Test condition E, (not applicable to UB suffix device).
* C6	1026	V_{GS} = -32 V dc for 2N4856, 2N4857, 2N4858, at T_A = +175°C ±5°C; V_{DS} = 0 V. V_{GS} = -24 V dc for 2N4859, 2N4860, 2N4861, at T_A = +175°C ±5°C; V_{DS} = 0 V.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

TABLE I. Group A inspection.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Gate to source breakdown voltage	3401	Bias condition C; I_G = -1.0 μA dc; V_{DS} = 0	$V_{(BR)GSS}$			
2N4856, 2N4857, 2N4858				-40		V dc
2N4859, 2N4860, 2N4861				-30		V dc
Gate reverse current	3411	Bias condition C; V_{DS} = 0	I_{GSS1}			
2N4856, 2N4857, 2N4858		V_{GS} = -20 V dc			-0.25	nA dc
2N4859, 2N4860, 2N4861		V_{GS} = -15 V dc			-0.25	nA dc
Drain current cutoff	3413	Bias condition A, V_{DS} = 15 V dc, V_{GS} = -10 V dc	$I_{D(off)}1$		0.25	nA dc
Drain current zero-gate voltage	3413	Bias condition C, V_{DS} = 15 V dc, V_{GS} = 0, pulsed (see 4.5.1)	I_{DSS}			
2N4856, 2N4859				50	175	mA dc
2N4857, 2N4860				20	100	mA dc
2N4858, 2N4861				8	80	mA dc
Drain to source on-state voltage	3405	Bias condition B, V_{GS} = 0	$V_{DS(on)}$			
2N4856, 2N4859		I_D = 20 mA dc			0.75	V dc
2N4857, 2N4860		I_D = 10 mA dc			0.50	V dc
2N4858, 2N4861		I_D = 5 mA dc			0.50	V dc
Gate to source off-state voltage	3403	V_{DS} = 15 V dc, I_D = 0.5 nA dc	$V_{GS(off)}$			
2N4856, 2N4859				-4	-10	V dc
2N4857, 2N4860				-2	-6	V dc
2N4858, 2N4861				-0.8	-4	V dc
Static drain to source on-state resistance	3421	V_{GS} = 0; I_D = 1.0 mA dc; I_d = 100 μA ac(rms), f = 1kHz	$r_{ds(on)}$			
2N4856, 2N4859					25	Ω
2N4857, 2N4860					40	Ω
2N4858, 2N4861					60	Ω

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High temperature operation:		T_A = +150°C				
Gate reverse current	3411	Bias condition C; V_{DS} = 0 V	I_{GSS2}			
2N4856, 2N4857, 2N4858		V_{GS} = -20 V dc			-0.5	µA dc
2N4859, 2N4860, 2N4861		V_{GS} = -15 V dc			-0.5	µA dc
Drain current	3413	Bias condition A, V_{DS} = 15 V dc; V_{GS} = -10 V dc	$I_{D(off)2}$		0.5	µA dc
Subgroup 4						
Small-signal common-source short-circuit input capacitance	3431	V_{DS} = 0, V_{GS} = -10 V; f = 1 MHz; C_1 = .1 µF, C_2= 20.1 µF $L_1 = L_2 = \geq 500$ µH	C_{iss}		18	pF
Small-signal common-source short-circuit reverse transfer capacitance	3433	V_{DS} = 0, V_{GS} = -10 V; f = 1 MHz; C_1 = .1 µF, $L_1 = L_2 = \geq 500$ µH	C_{rss}		8	pF
Turn-on delay time	3459	See figure 3	$t_{d(on)}$			
2N4856, 2N4859					6	ns
2N4857, 2N4860					6	ns
2N4858, 2N4861					10	ns
Rise time	3459	See figure 3	t_r			
2N4856, 2N4859					3	ns
2N4857, 2N4860					4	ns
2N4858, 2N4861					10	ns
Turn-off delay time	3459	See figure 3	$t_{d(off)}$			
2N4856, 2N4859					25	ns
2N4857, 2N4860					50	ns
2N4858, 2N4861					100	ns
Subgroups 5, 6, and 7						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.
2/ These characteristics applicable to all package styles, unless otherwise noted.

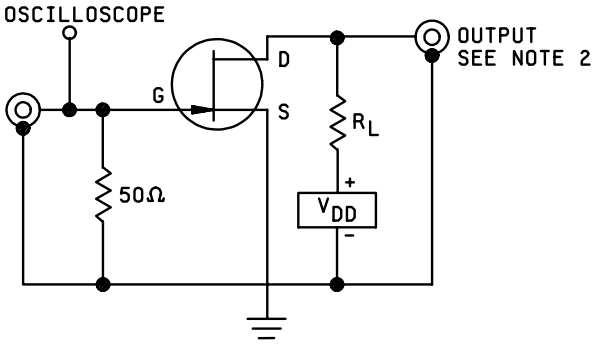
TABLE II. Groups B, C, and E delta measurements. 1/ 2/ 3/ 4/

Step	Inspection	MIL-STD-750		Symbol	Limit	Unit
		Method	Conditions			
1.	Static drain to source on-state resistance	3421	V_{GS} = 0; I_{DS} = 1.0 mA dc; I_d = 100 µA ac(rms), f = 1kHz	$\Delta r_{DS(on)}$	±25 percent change from previously measured value.	
2.	Drain current	3413	Bias condition C; V_{DS} = 15 V dc, V_{GS} = 0; pulsed (see 4.5.1)	ΔI_{DSS1}	±15 percent change from previously measured value.	

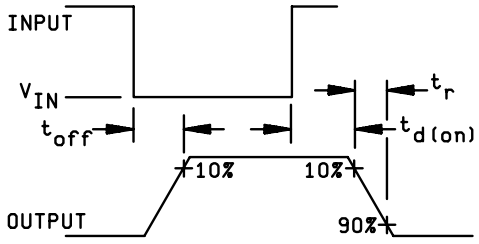
1/ Devices which exceed the group A limits for this test shall be rejected.
2/ The delta measurements for table E-VIA (JANS) of MIL-PRF-19500 are as follows: Subgroup 5, see table II herein, steps 1 and 2.
3/ The delta measurements for table E-VII of MIL-PRF-19500 are as follows: Subgroup 6, table II herein, steps 1 and 2 (for JANS only).
4/ The delta measurements for table E-IX of MIL-PRF-19500 are as follows: Subgroups 1 and 2, table II herein, steps 1 and 2.

* TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles.	
Hermetic seal Fine leak Gross leak	1071	 Test conditions G or H Test conditions C or D	
End-point electrical measurements		See table I, subgroup 2 and table II herein.	
Subgroup 2			45 devices c = 0
* Blocking life	1048	Test temperature = +125°C, V_{GS} or V_{DG} = 80 percent of rated, T = 1,000 hours.	
End-point electrical measurements		See table I, subgroup 2 and table II herein	
Subgroup 4 and 5			
Not applicable			
Subgroup 6			3 devices
ESD	1020	Testing not required for class 3 listing. Testing is required for nonsensitive listing to prove capability.	



TEST CIRCUIT



VOLTAGE WAVEFORMS

TEST CONDITIONS AND COMPONENT VALUE						
Type	V_{DD}	$V_{GS(on)}$	$V_{GS(off)}$	R_L	V_{IN}	$I_{D(on)}$ (1)
	V dc	V dc	V dc	Ω	V dc	mA dc
2N4856, 2N4859	10	0	-10	464	-10	20
2N4857, 2N4860	10	0	-6	953	-6	10
2N4858, 2N4861	10	0	-4	1,910	-4	5

(1) Nominal value; exact value varies slightly with transistor parameters.

NOTES:
1. The input waveform has the following characteristics:
   t_p = 200 ns; $t_r \leq 1$ ns; duty cycle ≈ 2 percent.
   It is supplied by a generator with Z_{out} = 50 Ω.
2. Waveforms are monitored on an oscilloscope with the following characteristics:
   $t_r \leq 0.75$ ns; $R_{IN} \geq 1$ MΩ; $C_{IN} \leq 2.5$ pF.
3. These characteristics applicable to all package styles, unless otherwise noted.

* FIGURE 3. Switching time test circuit.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Packaging requirements (see 5.1).

c. Lead finish (see 3.4.1).

d. Product assurance level and type designator.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2006-004)

Review activities:
Army - MI
Air Force - 71, 99

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